LINUX KERNEL:
STOP OVER-COOLING!

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# HARDWARE CONSTRAINT / PROBLEM STATEMENT

TIMING CLOSURE

- Any logic circuit will have a delay to propagate an input to output.

- This delay should be less than the time period between synchronizing clocks pulses.

- If the delay is greater than a clock cycle, the circuit will not function as expected.

- This is prevalent across process nodes.

Linaro
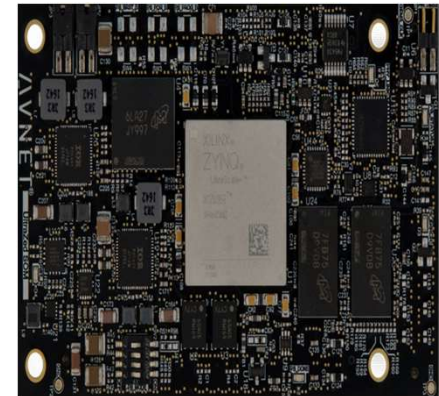
TEMPERATURE AND TIMING CLOSURE

- At lower temperatures, certain voltage and frequency combination **CANNOT** meet timing closure.

- Leads to non-functional system under extremely cold temperatures (< 0 degree Celsius)

- To close timing, the operating voltage must be increased.

- Opposite of what is required to cool down the system.
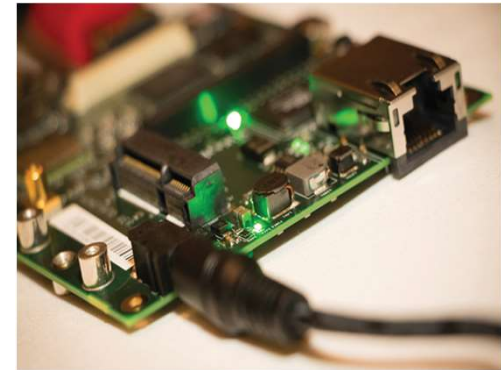
SOFTWARE / LINUX KERNEL

Linux Thermal Management Framework

- In-kernel framework exists to monitor temperature.

- ENTIRE FRAMEWORK IS BUILT AROUND MITIGATING RISING TEMPERATURE!

- So, what is needed ?
    - Thermal framework should handle descending temperature.

    - Thermal framework should support warming devices


BEST WAYS TO COOL DOWN THIS SUMMER

Linux Thermal Management Framework

- Thermal Zone
  - Area/device in a SoC that has thermal constraint.
  - Driver/Manager to manage the temperature requirements
- Sensors
  - Devices with temperature sensing capabilities (I2C ADC converters, bandgaps).
  - Provides temperature data to the framework.
- Trip Point
  - Point in the temperature domain upon crossing which a cooling action is initiated
- Cooling Devices
  - Devices providing control on power dissipation.
  - Range of cooling states
- Thermal Governor
  - Algorithm to manage the thermal zone temperature.

TRIP POINTS
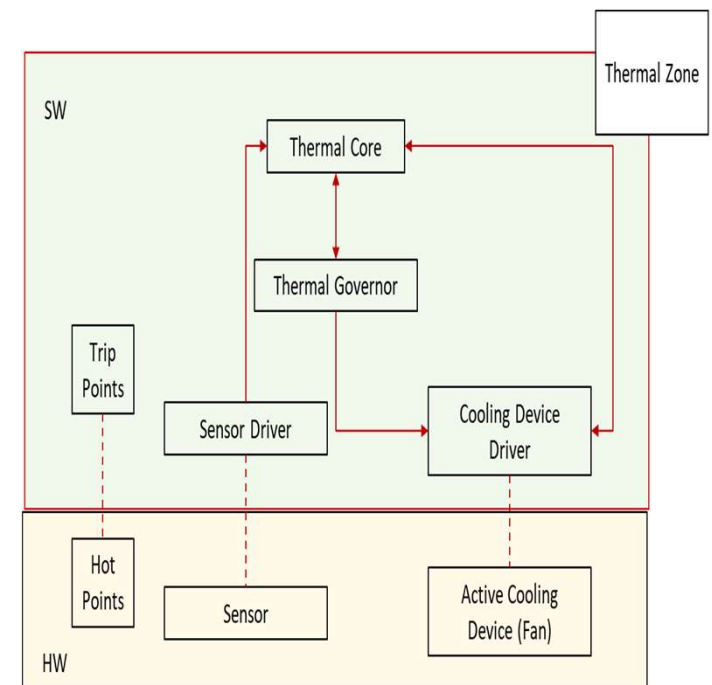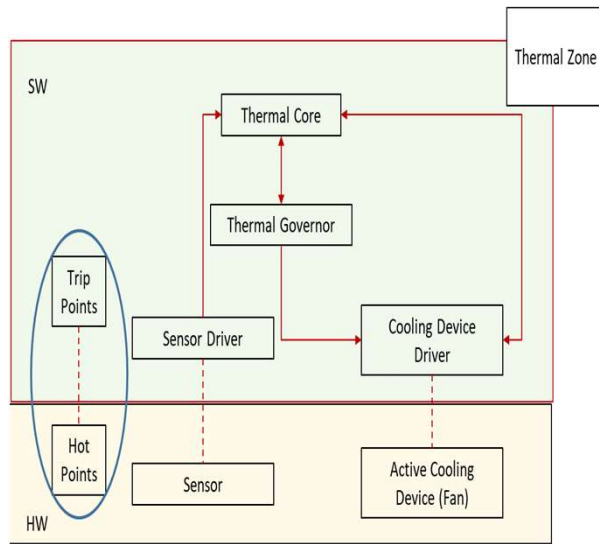
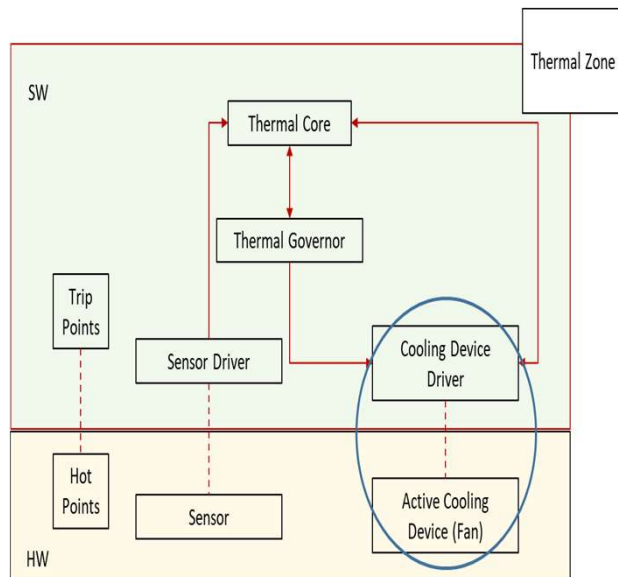| EXISITNG FRAMEWORK	EXTENSION NEEDED
HOT TRIP POINTS	COLD TRIP POINTS
Point in temperature domain, upon crossing which system undertakes a specified cooling action (ACTIVE, PASSIVE,HOT,CRITICAL)	Point in temperature domain, upon crossing which system undertakes a specified warming action

STATUS: WORK NOT YET STARTED

COOLING DEVICES AND DRIVERS

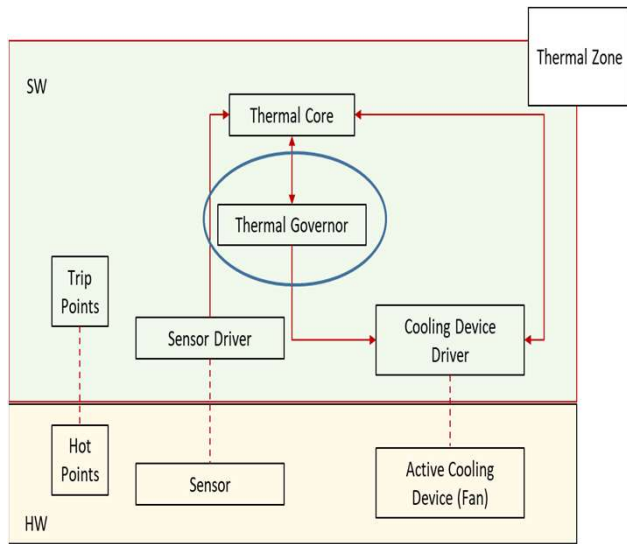| EXISITNG FRAMEWORK	EXTENSION NEEDED
ACTIVE COOLING DEVICES AND DRIVERS	SOFTWARE BASED WARMING MECHANISMS(GENPD BASED WARMING, DISABLING LOWER OPERATING POINTS OF DEVICES)
SOFTWARE BASED COOLING MECHANISMS(CPUFREQ COOLING, IDLE INJECTION)	RESOURCE SPECIFIC WARMING MECHANISMS
	Revisit term "Cooling" in the thermal framework

STATUS:

UPSTREAMED : Qualcomm AOSS based warming devices

IN PROGRESS: Generic Power domain based warming device driver (https://lkml.org/lkml/2020/6/3/1112)

NOT YET STARTED : Disabling lower OPP of devices.

THERMAL GOVERNOR

EXISITNG FRAMEWORK	EXTENSION NEEDED
STEP-WISE, IPA, BANG_BANG SUPPORT FOR MONITORING AND MITIGATING RISING TEMPERATURE (INTERRUPT BASED AND POLLING)	SUPPORT FOR MONITORING AND MITIGATING FALLING TEMPERATURE (TRIGGERING WARMING ACTION)

STATUS: WORK NOT YET STARTED

Thank you